PATENT ABSTRACTS OF JAPAN

(11)Publication number : **10-221710**

(43)Date of publication of application : **21.08.1998**

(51)Int.Cl. G02F 1/1347
G02B 5/28
G02F 1/1335

(21)Application number : **09-032938**

(22)Date of filing : **31.01.1997**

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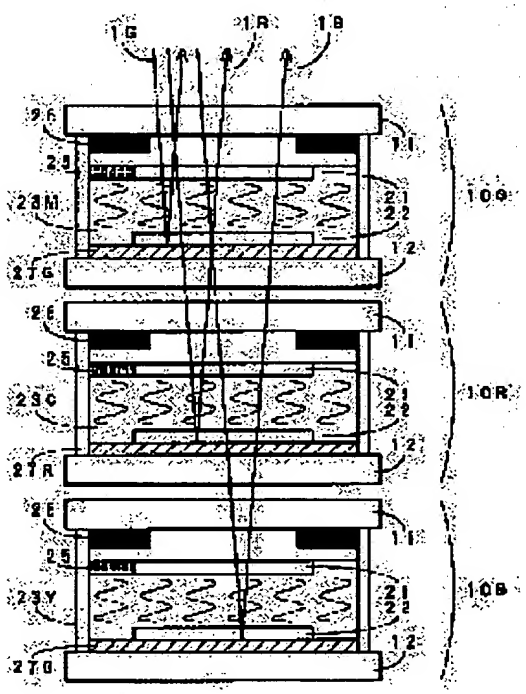
(54) REFLECTION TYPE COLOR DISPLAY DEVICE

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a multi-color displayable reflection type color display device capable of obtaining a high brightness display, remarkably improving particularly white display brightness, improving visibility and facilitating drive and manufacture of the device.

SOLUTION: Light control elements 10G, 10R, 10B are laminated successively from an external light incident side. Respective light control elements 10G, 10R, 10B form transparent pixel electrodes 21, 22, and are constituted so that light control layers 23M, 23C, 23Y consisting of a chiral nematic liquid crystal containing a dichroic dystuff and dichroic mirrors 27G, 27R, 27B with a dielectric multilayer film are formed between transparent substrates 11, 12 performed with planar orientation processing. The dichroic dystuff in the light control layers 23M, 23C, 23Y are made the dichroic dystuff of respective magenta, cyan and yellow, the reflection wavelength regions of the dichroic mirrors 27G, 27R, 27B are made wavelength regions of respective green, red and blue.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

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CLAIMS

[Claim(s)]
[Claim 1] While being able to take alternatively two conditions in the condition of absorbing with the condition of reflecting a specific wavelength field, respectively In the reflective mold electrochromatic display with which the laminating of two or more modulated light components which differ in the above-mentioned specific wavelength field mutually was carried out two or more above-mentioned modulated light components The dichroic mirror which reflects the above-mentioned specific wavelength field alternatively, respectively, It is the reflective mold electrochromatic display which has dichroism to the above-mentioned specific wavelength field established in the outdoor daylight incidence side of this dichroic mirror, and is characterized by equipping the other wavelength field with the modulated light layer made to penetrate mostly.
[Claim 2] It is the reflective mold electrochromatic display characterized by being three modulated light components to which two or more above-mentioned modulated light components make each above-mentioned specific wavelength field red, Green, and a blue wavelength field in a reflective mold electrochromatic display according to claim 1.
[Claim 3] It is the reflective mold electrochromatic display characterized by carrying out the laminating of that to which the three above-mentioned modulated light components make Green, red, and a blue wavelength field at order the above-mentioned specific wavelength field from an outdoor daylight incidence side in a reflective mold electrochromatic display according to claim 2.
[Claim 4] It is the reflective mold electrochromatic display characterized by for the dichroic mirror of the modulated light component of each above having adjoined the above-mentioned modulated light layer of the modulated light component by dielectric multilayers in the reflective mold electrochromatic display according to claim 1 to 3, and being formed.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the reflective mold electrochromatic display in which a multicolor display is possible.
[0002]
[Description of the Prior Art] The reflective mold electrochromatic display is briskly studied from the first with the low power with increase of the need of portable information machines and equipment, such as a notebook computer and PDA (Personal Digital Assistant), as that to which the need for the high flat-panel display of display quality, especially the flat-panel display in which color display is possible is increasing, and realizes it that it is a thin light weight.
[0003] Although various kinds of methods are proposed from the former as a reflective mold electrochromatic display the large color reproduction range -- realizable -- as what has easy full-color-izing -- Proceedings of SID'81 p -- 22 1981 and SID'96 Digest as [show / in p103-106] -- respectively -- yellow and a Magenta -- The laminating of the cel constituted with the guest host liquid crystal containing the dichroic coloring matter of cyanogen is carried out, and there is the so-called three layer laminating method of guest hosts which formed the reflecting plate in the opposite side an outdoor daylight incidence side further.
[0004] Drawing 4 shows an example of the reflective mold electrochromatic display of this three layer laminating method of guest hosts, by the case where the planar orientation mode of a chiral pneumatic liquid crystal is used, as mentioned above, carries out the laminating of the modulated light components 10G, 10R, and 10B which consist of a liquid crystal cell of guest host liquid crystal, respectively, and forms a reflecting plate 24 in the opposite side an outdoor daylight incidence side.
[0005] Each modulated light component 10G, 10R, and 10B Form the transparence pixel electrodes 21 and 22 which become the whole surface of two transparence substrates 11 and 12 which consist of glass etc. from ITO etc., and planar orientation processing is performed. The mixture which consists the transparence substrates 11 and 12 of the pneumatic liquid crystal which has a forward dielectric constant anisotropy as modulated light layers 23M, 23C, and 23Y between lamination, the transparence substrate 11, and 12 at intervals of several micrometers - about 10 micrometers of numbers, a chiral agent, dichroic coloring matter, etc. is poured in.
[0006] As a pneumatic liquid crystal which has a forward dielectric constant anisotropy, E-8 by Merck Co. generally marketed can be used, and ZLI-811 by Merck Co. generally marketed also as a chiral agent, CB15, etc. can be used. Into the mixture of the pneumatic liquid crystal and chiral agent, optimum dose mixing of a Magenta, cyanogen, and the dichroic coloring matter of yellow is carried out, respectively, and three kinds of mixture which serves as the modulated light layers 23M, 23C, and 23Y, respectively is obtained.
[0007] Generally as a Magenta, cyanogen, and dichroic coloring matter of yellow, what makes 535nm, 625nm, and near 445nm the central value of absorption wavelength, respectively is used, and M-618 by Mitsui Toatsu Chemicals, Inc., SI-497, SI-486, etc. can be used, respectively.

[0008] And after injecting each mixture into a cel, the inlet of each cel is closed and the electric-field impression means to the transparence pixel electrodes 21 and 22 is established to each cel. Then, the reflecting plate 24 which becomes superposition, an outdoor daylight input side, and the opposite side from an aluminum plate etc. in the cel 10G, 10R, and 10B of three sheets, i.e., modulated light components, is formed, and a reflective mold electrochromatic display is obtained.
[0009] As orientation mode of the liquid crystal molecule in the liquid crystal cell of the guest host liquid crystal containing dichroic coloring matter, the homogeneous orientation mode of not only the planar orientation mode of the above chiral pneumatic liquid crystals but a pneumatic liquid crystal can also be used. However, in the case of homogeneous orientation, a polarizing plate is needed. Moreover, the mode in which the macromolecule distribution liquid crystal (PDLC -- Polymer Dispersed Liquid Crystals) with which the pneumatic liquid crystal was distributed in the shape of drop let in the polymer was made to contain dichroic coloring matter can also be used.
[0010] The reflective mold electrochromatic display of the three layer laminating method of guest hosts mentioned above can obtain the large color reproduction range by the same coloring principle as a photograph, printing, etc.
[0011] However, the light which carried out incidence of this method to each pixel since the mechanical component 25 which consists of a switching element for each modulated light component 10G, 10R, and 10B being divided per pixel, and driving a pixel for every pixel, wiring, etc. existed will be intercepted by the mechanical component 25. Furthermore, in order to raise contrast generally, the black matrix 26 is formed in the transparence substrate 11 by the side of the outdoor daylight incidence of each modulated light component 10G, 10R, and 10B.
[0012] In practice, whenever the use effectiveness of light passes the modulated light component of one layer once, it becomes about 70 - 80%. Therefore, like the example of drawing 4 When Green colored light 1G in incident light, red colored light 1R, and blue colored light 1B are observed as the reflected light by going and coming back to the modulated light components 10G, 10R, and 10B of three layers, respectively, it will become 80% of about a little less than six batches, i.e., 30%.
[0013] Therefore, in the reflective mold electrochromatic display of the conventional guest host method mentioned above, at the time of the white display for which the color of the skillful color for which brightness is needed cannot be displayed, especially whenever [Takaaki] is needed, a high reflection factor is not obtained but there is a fault which is not enough.
[0014] As a reflective mold electrochromatic display which can solve such a problem, what used the modulated light component by the interference reflective method attracts attention recently. By the interference reflective method, on a principle, since the reflection factor near 100% is obtained in request wavelength, the color display of whenever [Takaaki] becomes possible. What is shown below is proposed by JP,4-355424,A as the modulated light component by this interference reflective method, and its manufacture approach.
[0015] That is, as shown in drawing 5 (A), the mixture 80 which made the pneumatic liquid crystal which has a forward dielectric constant anisotropy contain a photopolymerization nature compound is poured in, the coherent light is irradiated from both sides of a cel 70 at a cel 70, and the polymerization of the photopolymerization nature compound in mixture 80 is carried out to the cel 70 which made the transparence substrates 71 and 73 of the pair in which transparent electrodes 72 and 74 were formed counter an inside at the predetermined spacing, respectively by both interference.
[0016] At this time, as shown in drawing 5 (B), the compound by which the polymerization was carried out forms the polymer layer 83 the period decided by the wavelength and the angle of incidence of the coherent light for hologram writing, and a pneumatic liquid crystal deposits to fields other than polymer layer 83, and forms the liquid crystal layer 85. Therefore, in a transparent electrode 72 and the condition that an electrical potential difference is not impressed among 74, a periodic change of a refractive index can be produced in the modulated light layer 81, and reflection of specific wavelength can be produced.
[0017] And if the refractive index no to the ordinary light of liquid crystal and the refractive index np of a polymer are made equal, a transparent electrode 72 and where an electrical potential difference is impressed among 74, by carrying out orientation of the liquid crystal molecule in the direction of

electric field, a periodic change of the refractive index in the modulated light layer 81 will disappear, and all incident light will come to penetrate a cel 70. Therefore, according to a transparent electrode 72 and the electrical potential difference impressed among 74, the amount of reflected lights is controllable.

[0018] By this method, reflected wave length can be theoretically chosen according to the wavelength or the incident angle of the coherent light for hologram writing. By producing three modulated light components which follow, for example, make red, Green, and a blue wavelength field a reflected wave length field, respectively, and preparing a light absorption layer in the opposite side a superposition and outdoor daylight incidence side, the large color reproduction range can be obtained and a full color display is attained.
[0019] According to this method, and the light most reflected with the modulated light component by the side of outdoor daylight incidence Since it is observed only by going and coming back to the modulated light component by the side of outdoor daylight incidence most, the light which only two batches will be influenced of a numerical aperture and reflected with the middle modulated light component By going and coming back to the modulated light components of all three layers, since it is observed only by going and coming back to the modulated light component and the middle modulated light component by the side of outdoor daylight incidence most, only four batches will be influenced of a numerical aperture and only the light most reflected with the modulated light component of the opposite side the outdoor daylight incidence side comes to be observed.
[0020] Therefore, as compared with the conventional guest host method mentioned above, the display of whenever [Takaaki] can be obtained by preparing most the modulated light component which reflects the light of a color asked especially for brightness in an outdoor daylight incidence side. For example, about Green and red, a reflection factor respectively higher than a guest host method will be obtained by carrying out the laminating of the modulated light component to Green whose man is the order of a sensitive color, red, and blue order from an outdoor daylight incidence side to lightness.
[0021]
[Problem(s) to be Solved by the Invention] However, with the modulated light component by this interference reflective method, as shown in drawing 5 (C), while liquid crystal 86 will be distributed in the shape of drop let in a polymer 84, without the liquid crystal layer 85 being constituted by only liquid crystal 86, the direction of orientation of that liquid crystal drop let 86 becomes random.
[0022] Therefore, by the equalization by the refractive index of the polymer 84 by which the effectual refractive index of the liquid crystal layer 85 is contained in this, and the equalization by the random orientation of the liquid crystal drop let 86, it falls greatly and change of the periodic refractive index in the modulated light layer 81 becomes small. Therefore, lightness becomes low, when the half-value width of a reflectance spectrum becomes narrow and it uses as a display device.
[0023] Then, although it is not yet well-known, the modulated light component as shown as the 1st, 2nd, and 3rd example of a prior invention below is proposed by Japanese Patent Application No. No. (August 7, Heisei 8, application) 226046 [eight to].
[0024] The modulated light component of the 1st example of a prior invention pinches the modulated light layer 50 between the transparence substrate 11 and 12, as shown in drawing 6 . The insensible layer 51 and the induction layer 52 which mention the modulated light layer 50 later should be formed in Z shaft orientations (the opposite direction of the transparence substrates 11 and 12) by turns. On the transparence substrate 12, X shaft orientations (one direction perpendicular to Z shaft orientations) are made to extend in the shape of a stripe, respectively, and the electrodes 43 and 44 of the pair which counters Y shaft orientations (direction perpendicular to Z shaft orientations and X shaft orientations) mutually are formed.
[0025] This modulated light component is manufactured by the following approaches. First, form electrodes 43 and 44 on the transparence substrate 12, and homogeneous orientation processing is performed on the transparence substrate 11 and 12, respectively. Inject the liquid crystal which carried out little content of the photopolymerization nature compound etc. into the cel which stuck the transparence substrates 11 and 12 at intervals of the request, and the coherent light is irradiated from

both sides of a cel at a cel. The polymerization of the photopolymerization nature compound is carried out periodically, and an electrode 43 and the insensible layer 51 from which the orientation condition of a liquid crystal molecule does not change with the electrical potential differences impressed among 44 are formed.

[0026] Furthermore, after the fixed exposure time, ultraviolet radiation is irradiated at the whole cel and the induction layer 52 from which the orientation condition of a liquid crystal molecule may change with an electrode 43 and the electrical potential differences impressed among 44 between the insensible layers 51 is formed.

[0027] With this modulated light component, in an electrode 43 and the condition of not impressing an electrical potential difference among 44, as shown in drawing 6 (A), since orientation of the liquid crystal molecule in the modulated light layer 50 is uniformly carried out to X shaft orientations also in any of the insensible layer 51 and the induction layer 52, it does not produce a refractive-index difference between the insensible layer 51 and the induction layer 52, and does not produce the reflected light.

[0028] On the other hand, by impressing electric field to the modulated light layer 50 at Y shaft orientations, where an electrode 43 and electrical potential difference sufficient among 44 are impressed, as shown in drawing 6 (B), the direction of orientation of the liquid crystal molecule in the induction layer 52 changes to Y shaft orientations. Therefore, a refractive-index difference is produced between the insensible layer 51 and the induction layer 52, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.

[0029] Since orientation of the liquid crystal in the induction layer 52 is carried out to Y shaft orientations in the state of reflection of drawing 6 (B) to orientation of the liquid crystal in the insensible layer 51 being carried out to X shaft orientations according to this modulated light component, the refractive-index difference between the insensible layer 51 and the induction layer 52 becomes a very big thing almost equal to the rate of a birefringence of liquid crystal, and sufficiently large reflectance spectrum half-value width is obtained.

[0030] As the modulated light component of the 2nd example of a prior invention is shown in drawing 7 , between the transparence substrate 11 with which the transparent electrode 41 was formed, and the transparence substrate 12 with which the transparent electrode 42 was formed The modulated light layer 50 is pinched and 56 makes the 2nd layer of the modulated light layer 50 the thing orientation of the liquid crystal molecule was carried out [thing] to X shaft orientations, by which orientation was carried out to 55 and Y shaft orientations the 1st layer and which was formed in Z shaft orientations by turns.

[0031] This modulated light component is manufactured by the following approaches. First, form transparent electrodes 41 and 42 on the transparence substrate 11 and 12, and homogeneous orientation processing is performed, respectively. Inject the liquid crystal which carried out little content of the photopolymerization nature compound etc. into the cel which stuck the transparence substrates 11 and 12 at intervals of the request, and the coherent light is irradiated from both sides of a cel at a cel. the polymerization of the photopolymerization nature compound was carried out periodically, and orientation of the liquid crystal molecule was carried out to X shaft orientations, and the orientation condition was fixed -- 55 [layer / 1st] is formed.

[0032] furthermore, where a magnetic field sufficiently strong against Y shaft orientations is impressed, ultraviolet radiation was irradiated at the whole cel, and orientation of the 1st layer of the liquid crystal molecule was carried out to Y shaft orientations between 55, and the orientation condition was fixed -- 56 [layer / 2nd] is formed.

[0033] In the condition of not impressing an electrical potential difference between a transparent electrode 41 and 42 with this modulated light component As shown in drawing 7 (A), while orientation of the 1st layer of the liquid crystal molecule in the modulated light layer 50 is carried out to X shaft orientations in 55 Since orientation of the 2nd layer is carried out to Y shaft orientations in 56, the 1st layer of the 2nd layer of a refractive-index difference is produced between 56 with 55, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.

[0034] On the other hand, by impressing electric field to the modulated light layer 50 at Z shaft orientations, a transparent electrode 41 and where an electrical potential difference is impressed among 42, as shown in drawing 7 (B), the direction of orientation of the liquid crystal molecule in 1st layer 55 and the direction of orientation of the liquid crystal molecule in 2nd layer 56 change to Z shaft orientations, respectively. Therefore, the 1st layer of the 2nd layer of the refractive-index difference between 56 is lost with 55, and the reflected light disappears.
[0035] According to this modulated light component, in the state of reflection of drawing 7 (A), the 2nd layer of the 1st layer of the refractive-index difference between 56 becomes 55 and a very big thing almost equal to the rate of a birefringence of liquid crystal, and sufficiently large reflectance spectrum half-value width is obtained.
[0036] As the modulated light component of the 3rd example of a prior invention is shown in drawing 8 , between the transparence substrate 11 with which the transparent electrode 41 was formed, and the transparence substrate 12 with which the transparent electrode 42 was formed Pinch the modulated light layer 50, and while the drop of the pneumatic liquid crystal which has a forward dielectric constant anisotropy forms the modulated light layer 50 from the liquid crystal macromolecule complex distributed in the macromolecule matrix The liquid crystal in a drop makes the 2nd layer the thing by which orientation was carried out to X shaft orientations, by which orientation was carried out to 57 and Y shaft orientations the 1st layer and by which 58 was formed by turns in Z shaft orientations.
[0037] This modulated light component is manufactured by the following approaches. First, transparent electrodes 41 and 42 are formed on the transparence substrate 11 and 12.
[0038] Next, on the transparence substrate 12 in which the transparent electrode 42 was formed, the process of the following (1) - (4) is repeated 10 times, for example, and the modulated light layer 50 is formed.
(1) Carry out spin spreading of the mixed liquor of the pneumatic liquid crystal which has a forward dielectric constant anisotropy, a photopolymerization nature compound, and a solvent on the transparence substrate 12, and volatilize a solvent.
(2) Move this in the chamber of nitrogen-gas-atmosphere mind, using a super-conductive magnet, irradiate a magnetic field at Y shaft orientations, irradiate ultraviolet radiation with impression at the transparence substrate 12 whole, and form the macromolecule distribution liquid crystal layer which constitutes 58 [layer / 2nd].
(3) Carry out spin spreading of the above-mentioned mixed liquor on the transparence substrate 12, and volatilize a solvent.
(4) Move this in the chamber of nitrogen-gas-atmosphere mind, using a super-conductive magnet, irradiate a magnetic field at X shaft orientations, irradiate ultraviolet radiation with impression at the transparence substrate 12 whole, and form the macromolecule distribution liquid crystal layer which constitutes 57 [layer / 1st].
[0039] It is made for the thickness of one layer of the liquid crystal macromolecule complex after hardening to be set to about 80nm. Finally, the transparence substrate 11 in which the transparent electrode 41 was formed on the modulated light layer 50 is stuck.
[0040] In the condition of not impressing an electrical potential difference between a transparent electrode 41 and 42 with this modulated light component As shown in drawing 8 (A), while orientation of the 1st layer of the liquid crystal molecule in the drop in the modulated light layer 50 is carried out to X shaft orientations in 57 Since orientation of the 2nd layer is carried out to Y shaft orientations in 58, the 1st layer of the 2nd layer of a refractive-index difference is produced between 58 with 57, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.
[0041] On the other hand, by impressing electric field to the modulated light layer 50 at Z shaft orientations, a transparent electrode 41 and where an electrical potential difference is impressed among 42, as shown in drawing 8 (B), the direction of orientation of the liquid crystal molecule in the drop in 1st layer 57 and the direction of orientation of the liquid crystal molecule in the drop in 2nd layer 58 change to Z shaft orientations, respectively. Therefore, the 1st layer of the 2nd layer of the refractive-

index difference between 58 is lost with 57, and the reflected light disappears.
[0042] According to this modulated light component, in the state of reflection of drawing 8 (A), the 2nd layer of the 1st layer of the refractive-index difference between 58 becomes 57 and a very big thing, and sufficiently large reflectance spectrum half-value width is obtained.
[0043] The modulated light component of the 1st, 2nd, and 3rd example of a prior invention reflects the light of a specific wavelength field, or makes the light of a full wave length field penetrate according to the electrical potential difference impressed between an electrode 43 and 44 or between a transparent electrode 41 and 42, as mentioned above. By producing three modulated light components which follow, for example, make red, Green, and a blue wavelength field a reflected wave length field, respectively, and preparing a light absorption layer in the opposite side a superposition and outdoor daylight incidence side, the large color reproduction range can be obtained and a full color display is attained.
[0044] And as mentioned above, when change of the periodic refractive index in the modulated light layer 50 in a reflective condition becomes very large, sufficiently large reflectance spectrum half-value width is obtained and it uses as a display device, lightness becomes high enough and a very good display property is acquired.
[0045] However, since the modulated light component of the 1st example of the prior invention shown in drawing 6 forms the electrodes 43 and 44 for impressing the electric field of the direction of a field of substrates 11 and 12 in a pixel, the numerical aperture of a pixel falls remarkably. Furthermore, considering the drive by the electric field of the direction of a field, it is the threshold voltage Vt between a transparency condition and a reflective condition. Vt=(piL/d) x(k2/epsilonodeltaepsilon) 1/2 - - (1)
It becomes. However, for L, an electrode 43, the distance between 44, and d are [the twist elastic modulus of liquid crystal and deltaepsilon of the thickness of the modulated light layer 50 and k2] the dielectric constant anisotropies of liquid crystal.
[0046] And since d is equivalent to the thickness for every layer which forms periodic structure, it is the value of wavelength of light and is very as small as about several 10-100nm. Therefore, while an electrical potential difference very high as threshold voltage Vt is needed and the drive of a component becomes difficult, power consumption increases.
[0047] Moreover, in order that the modulated light component of the 2nd and 3rd example of the prior invention shown in drawing 7 and drawing 8 may control the direction of orientation of a liquid crystal molecule by impressing a magnetic field in the manufacture process, a very strong magnetic field is needed. Therefore, it becomes difficult to impress a magnetic field uniformly over a large area, and there is difficulty the productivity of a component, and in respect of homogeneity.
[0048] Then, while visibility becomes good by the large color reproduction range being not only realizable, but being able to obtain the display of whenever [Takaaki] and especially the lightness of a white display improving sharply, it is made for a drive and manufacture of equipment to become easy in the reflective mold electrochromatic display which this invention can multicolor display.
[0049]
[Means for Solving the Problem] While being able to take alternatively two conditions in the condition of absorbing with the condition of reflecting a specific wavelength field, respectively, in this invention In the reflective mold electrochromatic display with which the laminating of two or more modulated light components which differ in the above-mentioned specific wavelength field mutually was carried out two or more above-mentioned modulated light components It shall have dichroism to the above-mentioned specific wavelength field which established the above-mentioned specific wavelength field in the outdoor daylight incidence side of the dichroic mirror reflected alternatively and this dichroic mirror, respectively, and the other wavelength field should be equipped with the modulated light layer made to penetrate mostly.
[0050] In this case, two or more above-mentioned modulated light components can be used as three modulated light components which make each above-mentioned specific wavelength field red, Green, and a blue wavelength field.
[0051] In that case, as for the three modulated light components, it is desirable to carry out the

laminating of what makes Green, red, and a blue wavelength field the above-mentioned specific wavelength field to order from an outdoor daylight incidence side.
[0052] Moreover, as for the dichroic mirror of the modulated light component of each above, it is desirable to adjoin the above-mentioned modulated light layer of the modulated light component, and to form by dielectric multilayers.
[0053]
[Function] In the reflective mold electrochromatic display of this invention constituted as mentioned above when the typical case where the laminating of the three modulated light components was carried out was shown If the modulated light component by the side of outdoor daylight incidence is made into the 1st layer and the 2nd layer of the modulated light component of the opposite side is most made into the 3rd layer for a middle modulated light component an outdoor daylight incidence side, the light of the 1st color which penetrated the layer [1st] modulated light layer It reflects with the dichroic mirror of the 1st layer, and is observed as the reflected light only by going and coming back to the modulated light component of the 1st layer, and only two batches are influenced of a numerical aperture.
[0054] Moreover, the light of the 2nd color which penetrated a layer [1st] modulated light layer, and a dichroic mirror and a layer [2nd] modulated light layer is reflected with the dichroic mirror of the 2nd layer, it is observed as the reflected light only by going and coming back to the modulated light component of the 1st layer and the 2nd layer, and only four batches are influenced of a numerical aperture.
[0055] Only the light of the 3rd color which penetrated a layer [1st] modulated light layer, a dichroic mirror and a layer [2nd] modulated light layer, and a dichroic mirror and a layer [3rd] modulated light layer reflects with the dichroic mirror of the 3rd layer, and is observed as the reflected light by going and coming back to the modulated light components of all three layers.
[0056] Therefore, the display of whenever [Takaaki] can be obtained by making into the 1st layer the modulated light component which reflects the light of a color asked especially for brightness with a dichroic mirror.
[0057] Since a modulated light component will be arranged from an observation side in order of a color with sensitive people to lightness in the modulated light component of the 1st layer, the 2nd layer, and the 3rd layer when reflecting Green, red, and a blue wavelength field with a dichroic mirror, respectively, while being able to express skillful color, especially the lightness of a white display improves sharply.
[0058] Moreover, since it is located inside the substrate with which each dichroic mirror constitutes a modulated light component and the effect of the numerical aperture of a modulated light component to the reflected light becomes only a part for one way mostly in adjoining the modulated light layer of the modulated light component and forming the dichroic mirror of each modulated light component by dielectric multilayers, it crosses to a full wave length field, and a reflection factor improves.
[0059]
[Embodiment of the Invention] Drawing 1 is the case where an example of the reflective mold electrochromatic display of this invention was shown, and the laminating of the three modulated light components 10G, 10R, and 10B is carried out.
[0060] Each modulated light component 10G, 10R, and 10B The transparence pixel electrode 21 which consists of a mechanical component 25 which becomes the whole surface of the transparence substrate 11 which consists of glass etc. from switching elements, such as the black matrix 26 and a thin film transistor, wiring, etc., ITO, etc. is formed. While producing an active-matrix substrate, on the whole surface of the transparence substrate 12 which consists of glass etc. By dielectric multilayers, dichroic mirrors 27G, 27R, and 27B are formed, the transparence pixel electrode 22 which consists of ITO etc. is formed on it, an opposite substrate is produced, and planar orientation processing is performed to the field by the side of each transparence pixel electrode 21 and 22. And the transparence substrates 11 and 12 are stuck at intervals of several micrometers - about 10 micrometers of numbers so that transparence pixel electrode 21 and 22 side may turn into the inside, and a cel is produced.
[0061] It is made, as for 580nm or more and dichroic mirror 27B, for 490nm - 580nm and dichroic

mirror 27R to be set [the dichroic mirrors 27G 27R, and 27B by dielectric multilayers / the reflected wave length field] to 490nm or less by dichroic mirror 27G. Concretely, ZrO2 etc. can be used as the high refractive-index film, MgF2 etc. can be used as low refractive-index film, respectively, and each film is formed with electron beam vacuum deposition.

[0062] The main wavelength and bandwidth of a reflected wave length field of dichroic mirrors 27G, 27R, and 27B are easily controllable by the thickness of the periodic film, the ratio of each refractive index, and the ratio of thickness.

[0063] And the mixture which becomes the cel of each modulated light component 10G, 10R, and 10B from the pneumatic liquid crystal which has a forward dielectric constant anisotropy as modulated light layers 23M, 23C, and 23Y, a chiral agent, dichroic coloring matter, etc. is poured in, and an inlet is closed.

[0064] As a pneumatic liquid crystal which has a forward dielectric constant anisotropy, E-8 by Merck Co. generally marketed can be used, and ZLI-811 by Merck Co. generally marketed also as a chiral agent, CB15, etc. can be used. The mixing ratio of the pneumatic liquid crystal and chiral agent is adjusted so that the selective reflection wavelength of a chiral pneumatic liquid crystal may not serve as a light field.

[0065] the mixture of the pneumatic liquid crystal and chiral agent -- modulated light layer 23M -- the central value of absorption wavelength -- the dichroic coloring matter of the Magenta near 535nm -- about modulated light layer 23C, the dichroic coloring matter of the cyanogen near 625nm is mixed, and the central value of absorption wavelength mixes [the central value of absorption wavelength] the dichroic coloring matter of the yellow near 445nm about modulated light layer 23Y, respectively. As the Magenta, cyanogen, and dichroic coloring matter of yellow, M-618 by Mitsui Toatsu Chemicals, Inc., SI-497, SI-486, etc. can be used, respectively. Although the mixing ratio of dichroic coloring matter is determined on the balance of contrast and the maximum permeability, generally let it be 0.5% - several% of range.

[0066] It is made, as for the combination of the dichroic mirror in the same modulated light component, and the dichroic coloring matter in a modulated light layer, for the absorption color of dichroic coloring matter to turn into the complementary color to the reflected color of a dichroic mirror so that already clearly from the place mentioned above. That is, to dichroic mirror 27B which reflects blue colored light 1B for the dichroic coloring matter of cyanogen to dichroic mirror 27R which reflects red colored light 1R for the dichroic coloring matter of a Magenta to dichroic mirror 27G which reflect Green colored light 1G, the dichroic coloring matter of yellow is combined, respectively.

[0067] Thus, a liquid crystal driving means is connected to the produced modulated light components 10G, 10R, and 10B, respectively, and they are made to complete lamination and a reflective mold electrochromatic display for three modulated light components in piles from an outdoor daylight incidence side further in order of the modulated light components 10G, 10R, and 10B.

[0068] In the reflective mold electrochromatic display of this example Green colored light 1G in incident light Modulated light layer 23M are penetrated, it reflects by dichroic mirror 27G, modulated light layer 23M are penetrated again, and it is observed as the reflected light. Red colored light 1R Modulated light layer 23M, dichroic mirror 27G, and modulated light layer 23C are penetrated. It reflects by dichroic mirror 27R, modulated light layer 23C, dichroic mirror 27G, and modulated light layer 23M are penetrated again, and it is observed as the reflected light. Blue colored light 1B Modulated light layer 23M, dichroic mirror 27G, modulated light layer 23C, and dichroic mirror 27R and modulated light layer 23Y are penetrated. It reflects by dichroic mirror 27B, modulated light layer 23Y, dichroic mirror 27R, modulated light layer 23C, dichroic mirror 27G, and modulated light layer 23M are penetrated again, and it is observed as the reflected light.

[0069] The color reproduction range by the reflective mold electrochromatic display of this example is shown in drawing 2 (A), the color reproduction range by the reflective mold electrochromatic display of the conventional three layer laminating method of guest hosts shown and mentioned above to drawing 4 is shown in drawing 2 (B), and both comparison result is shown in drawing 3 . However, while seeing on CIE and L*a*b* space, 80%, the dichroic ratio of dichroic coloring matter is [gain] a zero state, and

the numerical aperture of the modulated light component of one layer compares the reflecting plate 24 of 10 and drawing 4 .

[0070] From now on, according to the reflective mold electrochromatic display of the example of drawing 1 , compared with the conventional example shown in drawing 4 , especially the lightness of a white display will improve sharply so that clearly. Furthermore, the color gamut of yellow, Green, and the direction of cyanogen is expanded, and lightness also improves.

[0071] As mentioned above, Green colored light 1G reflect this by dichroic mirror 27G. From dichroic mirror 27G of modulated light component 10G, it is observed as the reflected light only by going and coming back to the part by the side of outdoor daylight incidence, and red colored light 1R reflects by dichroic mirror 27R. It is because it is observed as the reflected light only by going and coming back to the part by the side of outdoor daylight incidence, and modulated light component 10G from dichroic mirror 27of modulated light component 10R R.

[0072] Moreover, while a high electrical potential difference cannot be needed for the drive of a component and being able to drive a component easily like the modulated light component of the 1st example of the prior invention shown and mentioned above to drawing 6 , there is no need that a strong magnetic field is impressed in the manufacture process of a component, like the modulated light component of the 2nd and 3rd example of the prior invention shown and mentioned above to drawing 7 and drawing 8 , and a component can be manufactured easily.

[0073] Although the example of drawing 1 is the case where the chiral pneumatic liquid crystal of planar orientation is used, as modulated light layers 23M, 23C, and 23Y of guest host liquid crystal, what combined the cel and polarizing plate of a pneumatic liquid crystal not only of this but homogeneous orientation, the thing using macromolecule distribution liquid crystal (PDLC), etc. can be used for it, and it can acquire the same effectiveness even in such a case.

[0074]

[Effect of the Invention] As mentioned above, while the large color reproduction range being not only realizable, but according to this invention being able to obtain the display of whenever [Takaaki], especially the lightness of a white display improving sharply and visibility's becoming good in the reflective mold electrochromatic display in which a multicolor display is possible, a drive and manufacture of equipment become easy.

[Translation done.]

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TECHNICAL FIELD

[Field of the Invention] This invention relates to the reflective mold electrochromatic display in which a multicolor display is possible.

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PRIOR ART

[Description of the Prior Art] The reflective mold electrochromatic display is briskly studied from the first with the low power with increase of the need of portable information machines and equipment, such as a notebook computer and PDA (Personal Digital Assistant), as that to which the need for the high flat-panel display of display quality, especially the flat-panel display in which color display is possible is increasing, and realizes it that it is a thin light weight.
[0003] Although various kinds of methods are proposed from the former as a reflective mold electrochromatic display the large color reproduction range -- realizable -- as what has easy full-color-izing -- Proceedings of SID'81 p -- 22 1981 and SID'96 Digest as [show / in p103-106] -- respectively -- yellow and a Magenta -- The laminating of the cel constituted with the guest host liquid crystal containing the dichroic coloring matter of cyanogen is carried out, and there is the so-called three layer laminating method of guest hosts which formed the reflecting plate in the opposite side an outdoor daylight incidence side further.
[0004] Drawing 4 shows an example of the reflective mold electrochromatic display of this three layer laminating method of guest hosts, by the case where the planar orientation mode of a chiral pneumatic liquid crystal is used, as mentioned above, carries out the laminating of the modulated light components 10G, 10R, and 10B which consist of a liquid crystal cell of guest host liquid crystal, respectively, and forms a reflecting plate 24 in the opposite side an outdoor daylight incidence side.
[0005] Each modulated light component 10G, 10R, and 10B Form the transparence pixel electrodes 21 and 22 which become the whole surface of two transparence substrates 11 and 12 which consist of glass etc. from ITO etc., and planar orientation processing is performed. The mixture which consists the transparence substrates 11 and 12 of the pneumatic liquid crystal which has a forward dielectric constant anisotropy as modulated light layers 23M, 23C, and 23Y between lamination, the transparence substrate 11, and 12 at intervals of several micrometers - about 10 micrometers of numbers, a chiral agent, dichroic coloring matter, etc. is poured in.
[0006] As a pneumatic liquid crystal which has a forward dielectric constant anisotropy, E-8 by Merck Co. generally marketed can be used, and ZLI-811 by Merck Co. generally marketed also as a chiral agent, CB15, etc. can be used. Into the mixture of the pneumatic liquid crystal and chiral agent, optimum dose mixing of a Magenta, cyanogen, and the dichroic coloring matter of yellow is carried out, respectively, and three kinds of mixture which serves as the modulated light layers 23M, 23C, and 23Y, respectively is obtained.
[0007] Generally as a Magenta, cyanogen, and dichroic coloring matter of yellow, what makes 535nm, 625nm, and near 445nm the central value of absorption wavelength, respectively is used, and M-618 by Mitsui Toatsu Chemicals, Inc., SI-497, SI-486, etc. can be used, respectively.
[0008] And after injecting each mixture into a cel, the inlet of each cel is closed and the electric-field impression means to the transparence pixel electrodes 21 and 22 is established to each cel. Then, the reflecting plate 24 which becomes superposition, an outdoor daylight input side, and the opposite side from an aluminum plate etc. in the cel 10G, 10R, and 10B of three sheets, i.e., modulated light components, is formed, and a reflective mold electrochromatic display is obtained.

[0009] As orientation mode of the liquid crystal molecule in the liquid crystal cell of the guest host liquid crystal containing dichroic coloring matter, the homogeneous orientation mode of not only the planar orientation mode of the above chiral pneumatic liquid crystals but a pneumatic liquid crystal can also be used. However, in the case of homogeneous orientation, a polarizing plate is needed. Moreover, the mode in which the macromolecule distribution liquid crystal (PDLC -- Polymer Dispersed Liquid Crystals) with which the pneumatic liquid crystal was distributed in the shape of drop let in the polymer was made to contain dichroic coloring matter can also be used.
[0010] The reflective mold electrochromatic display of the three layer laminating method of guest hosts mentioned above can obtain the large color reproduction range by the same coloring principle as a photograph, printing, etc.
[0011] However, the light which carried out incidence of this method to each pixel since the mechanical component 25 which consists of a switching element for each modulated light component 10G, 10R, and 10B being divided per pixel, and driving a pixel for every pixel, wiring, etc. existed will be intercepted by the mechanical component 25. Furthermore, in order to raise contrast generally, the black matrix 26 is formed in the transparence substrate 11 by the side of the outdoor daylight incidence of each modulated light component 10G, 10R, and 10B.
[0012] In practice, whenever the use effectiveness of light passes the modulated light component of one layer once, it becomes about 70 - 80%. Therefore, like the example of drawing 4 When Green colored light 1G in incident light, red colored light 1R, and blue colored light 1B are observed as the reflected light by going and coming back to the modulated light components 10G, 10R, and 10B of three layers, respectively, it will become 80% of about a little less than six batches, i.e., 30%.
[0013] Therefore, in the reflective mold electrochromatic display of the conventional guest host method mentioned above, at the time of the white display for which the color of the skillful color for which brightness is needed cannot be displayed, especially whenever [Takaaki] is needed, a high reflection factor is not obtained but there is a fault which is not enough.
[0014] As a reflective mold electrochromatic display which can solve such a problem, what used the modulated light component by the interference reflective method attracts attention recently. By the interference reflective method, on a principle, since the reflection factor near 100% is obtained in request wavelength, the color display of whenever [Takaaki] becomes possible. What is shown below is proposed by JP,4-355424,A as the modulated light component by this interference reflective method, and its manufacture approach.
[0015] That is, as shown in drawing 5 (A), the mixture 80 which made the pneumatic liquid crystal which has a forward dielectric constant anisotropy contain a photopolymerization nature compound is poured in, the coherent light is irradiated from both sides of a cel 70 at a cel 70, and the polymerization of the photopolymerization nature compound in mixture 80 is carried out to the cel 70 which made the transparence substrates 71 and 73 of the pair in which transparent electrodes 72 and 74 were formed counter an inside at the predetermined spacing, respectively by both interference.
[0016] At this time, as shown in drawing 5 (B), the compound by which the polymerization was carried out forms the polymer layer 83 the period decided by the wavelength and the angle of incidence of the coherent light for hologram writing, and a pneumatic liquid crystal deposits to fields other than polymer layer 83, and forms the liquid crystal layer 85. Therefore, in a transparent electrode 72 and the condition that an electrical potential difference is not impressed among 74, a periodic change of a refractive index can be produced in the modulated light layer 81, and reflection of specific wavelength can be produced.
[0017] And if the refractive index no to the ordinary light of liquid crystal and the refractive index np of a polymer are made equal, a transparent electrode 72 and where an electrical potential difference is impressed among 74, by carrying out orientation of the liquid crystal molecule in the direction of electric field, a periodic change of the refractive index in the modulated light layer 81 will disappear, and all incident light will come to penetrate a cel 70. Therefore, according to a transparent electrode 72 and the electrical potential difference impressed among 74, the amount of reflected lights is controllable.

[0018] By this method, reflected wave length can be theoretically chosen according to the wavelength or

the incident angle of the coherent light for hologram writing. By producing three modulated light components which follow, for example, make red, Green, and a blue wavelength field a reflected wave length field, respectively, and preparing a light absorption layer in the opposite side a superposition and outdoor daylight incidence side, the large color reproduction range can be obtained and a full color display is attained.

[0019] According to this method, and the light most reflected with the modulated light component by the side of outdoor daylight incidence Since it is observed only by going and coming back to the modulated light component by the side of outdoor daylight incidence most, the light which only two batches will be influenced of a numerical aperture and reflected with the middle modulated light component By going and coming back to the modulated light components of all three layers, since it is observed only by going and coming back to the modulated light component and the middle modulated light component by the side of outdoor daylight incidence most, only four batches will be influenced of a numerical aperture and only the light most reflected with the modulated light component of the opposite side the outdoor daylight incidence side comes to be observed.

[0020] Therefore, as compared with the conventional guest host method mentioned above, the display of whenever [Takaaki] can be obtained by preparing most the modulated light component which reflects the light of a color asked especially for brightness in an outdoor daylight incidence side. For example, about Green and red, a reflection factor respectively higher than a guest host method will be obtained by carrying out the laminating of the modulated light component to Green whose man is the order of a sensitive color, red, and blue order from an outdoor daylight incidence side to lightness.

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EFFECT OF THE INVENTION

[Effect of the Invention] As mentioned above, while the large color reproduction range being not only realizable, but according to this invention being able to obtain the display of whenever [Takaaki], especially the lightness of a white display improving sharply and visibility's becoming good in the reflective mold electrochromatic display in which a multicolor display is possible, a drive and manufacture of equipment become easy.

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TECHNICAL PROBLEM

[Problem(s) to be Solved by the Invention] However, with the modulated light component by this interference reflective method, as shown in drawing 5 (C), while liquid crystal 86 will be distributed in the shape of drop let in a polymer 84, without the liquid crystal layer 85 being constituted by only liquid crystal 86, the direction of orientation of that liquid crystal drop let 86 becomes random.
[0022] Therefore, by the equalization by the refractive index of the polymer 84 by which the effectual refractive index of the liquid crystal layer 85 is contained in this, and the equalization by the random orientation of the liquid crystal drop let 86, it falls greatly and change of the periodic refractive index in the modulated light layer 81 becomes small. Therefore, lightness becomes low, when the half-value width of a reflectance spectrum becomes narrow and it uses as a display device.
[0023] Then, although it is not yet well-known, the modulated light component as shown as the 1st, 2nd, and 3rd example of a prior invention below is proposed by Japanese Patent Application No. No. (August 7, Heisei 8, application) 226046 [eight to].
[0024] The modulated light component of the 1st example of a prior invention pinches the modulated light layer 50 between the transparence substrate 11 and 12, as shown in drawing 6 . The insensible layer 51 and the induction layer 52 which mention the modulated light layer 50 later should be formed in Z shaft orientations (the opposite direction of the transparence substrates 11 and 12) by turns. On the transparence substrate 12, X shaft orientations (one direction perpendicular to Z shaft orientations) are made to extend in the shape of a stripe, respectively, and the electrodes 43 and 44 of the pair which counters Y shaft orientations (direction perpendicular to Z shaft orientations and X shaft orientations) mutually are formed.
[0025] This modulated light component is manufactured by the following approaches. First, form electrodes 43 and 44 on the transparence substrate 12, and homogeneous orientation processing is performed on the transparence substrate 11 and 12, respectively. Inject the liquid crystal which carried out little content of the photopolymerization nature compound etc. into the cel which stuck the transparence substrates 11 and 12 at intervals of the request, and the coherent light is irradiated from both sides of a cel at a cel. The polymerization of the photopolymerization nature compound is carried out periodically, and an electrode 43 and the insensible layer 51 from which the orientation condition of a liquid crystal molecule does not change with the electrical potential differences impressed among 44 are formed.
[0026] Furthermore, after the fixed exposure time, ultraviolet radiation is irradiated at the whole cel and the induction layer 52 from which the orientation condition of a liquid crystal molecule may change with an electrode 43 and the electrical potential differences impressed among 44 between the insensible layers 51 is formed.
[0027] With this modulated light component, in an electrode 43 and the condition of not impressing an electrical potential difference among 44, as shown in drawing 6 (A), since orientation of the liquid crystal molecule in the modulated light layer 50 is uniformly carried out to X shaft orientations also in any of the insensible layer 51 and the induction layer 52, it does not produce a refractive-index difference between the insensible layer 51 and the induction layer 52, and does not produce the reflected

light.
[0028] On the other hand, by impressing electric field to the modulated light layer 50 at Y shaft orientations, where an electrode 43 and electrical potential difference sufficient among 44 are impressed, as shown in drawing 6 (B), the direction of orientation of the liquid crystal molecule in the induction layer 52 changes to Y shaft orientations. Therefore, a refractive-index difference is produced between the insensible layer 51 and the induction layer 52, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.
[0029] Since orientation of the liquid crystal in the induction layer 52 is carried out to Y shaft orientations in the state of reflection of drawing 6 (B) to orientation of the liquid crystal in the insensible layer 51 being carried out to X shaft orientations according to this modulated light component, the refractive-index difference between the insensible layer 51 and the induction layer 52 becomes a very big thing almost equal to the rate of a birefringence of liquid crystal, and sufficiently large reflectance spectrum half-value width is obtained.
[0030] As the modulated light component of the 2nd example of a prior invention is shown in drawing 7 , between the transparence substrate 11 with which the transparent electrode 41 was formed, and the transparence substrate 12 with which the transparent electrode 42 was formed The modulated light layer 50 is pinched and 56 makes the 2nd layer of the modulated light layer 50 the thing orientation of the liquid crystal molecule was carried out [thing] to X shaft orientations, by which orientation was carried out to 55 and Y shaft orientations the 1st layer and which was formed in Z shaft orientations by turns.
[0031] This modulated light component is manufactured by the following approaches. First, form transparent electrodes 41 and 42 on the transparence substrate 11 and 12, and homogeneous orientation processing is performed, respectively. Inject the liquid crystal which carried out little content of the photopolymerization nature compound etc. into the cel which stuck the transparence substrates 11 and 12 at intervals of the request, and the coherent light is irradiated from both sides of a cel at a cel. the polymerization of the photopolymerization nature compound was carried out periodically, and orientation of the liquid crystal molecule was carried out to X shaft orientations, and the orientation condition was fixed -- 55 [layer / 1st] is formed.
[0032] furthermore, where a magnetic field sufficiently strong against Y shaft orientations is impressed, ultraviolet radiation was irradiated at the whole cel, and orientation of the 1st layer of the liquid crystal molecule was carried out to Y shaft orientations between 55, and the orientation condition was fixed -- 56 [layer / 2nd] is formed.
[0033] In the condition of not impressing an electrical potential difference between a transparent electrode 41 and 42 with this modulated light component As shown in drawing 7 (A), while orientation of the 1st layer of the liquid crystal molecule in the modulated light layer 50 is carried out to X shaft orientations in 55 Since orientation of the 2nd layer is carried out to Y shaft orientations in 56, the 1st layer of the 2nd layer of a refractive-index difference is produced between 56 with 55, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.
[0034] On the other hand, by impressing electric field to the modulated light layer 50 at Z shaft orientations, a transparent electrode 41 and where an electrical potential difference is impressed among 42, as shown in drawing 7 (B), the direction of orientation of the liquid crystal molecule in 1st layer 55 and the direction of orientation of the liquid crystal molecule in 2nd layer 56 change to Z shaft orientations, respectively. Therefore, the 1st layer of the 2nd layer of the refractive-index difference between 56 is lost with 55, and the reflected light disappears.
[0035] According to this modulated light component, in the state of reflection of drawing 7 (A), the 2nd layer of the 1st layer of the refractive-index difference between 56 becomes 55 and a very big thing almost equal to the rate of a birefringence of liquid crystal, and sufficiently large reflectance spectrum half-value width is obtained.
[0036] As the modulated light component of the 3rd example of a prior invention is shown in drawing 8 , between the transparence substrate 11 with which the transparent electrode 41 was formed, and the transparence substrate 12 with which the transparent electrode 42 was formed Pinch the modulated light

layer 50, and while the drop of the pneumatic liquid crystal which has a forward dielectric constant anisotropy forms the modulated light layer 50 from the liquid crystal macromolecule complex distributed in the macromolecule matrix The liquid crystal in a drop makes the 2nd layer the thing by which orientation was carried out to X shaft orientations, by which orientation was carried out to 57 and Y shaft orientations the 1st layer and by which 58 was formed by turns in Z shaft orientations.
[0037] This modulated light component is manufactured by the following approaches. First, transparent electrodes 41 and 42 are formed on the transparence substrate 11 and 12.
[0038] Next, on the transparence substrate 12 in which the transparent electrode 42 was formed, the process of the following (1) - (4) is repeated 10 times, for example, and the modulated light layer 50 is formed.
(1) Carry out spin spreading of the mixed liquor of the pneumatic liquid crystal which has a forward dielectric constant anisotropy, a photopolymerization nature compound, and a solvent on the transparence substrate 12, and volatilize a solvent.
(2) Move this in the chamber of nitrogen-gas-atmosphere mind, using a super-conductive magnet, irradiate a magnetic field at Y shaft orientations, irradiate ultraviolet radiation with impression at the transparence substrate 12 whole, and form the macromolecule distribution liquid crystal layer which constitutes 58 [layer / 2nd].
(3) Carry out spin spreading of the above-mentioned mixed liquor on the transparence substrate 12, and volatilize a solvent.
(4) Move this in the chamber of nitrogen-gas-atmosphere mind, using a super-conductive magnet, irradiate a magnetic field at X shaft orientations, irradiate ultraviolet radiation with impression at the transparence substrate 12 whole, and form the macromolecule distribution liquid crystal layer which constitutes 57 [layer / 1st].
[0039] It is made for the thickness of one layer of the liquid crystal macromolecule complex after hardening to be set to about 80nm. Finally, the transparence substrate 11 in which the transparent electrode 41 was formed on the modulated light layer 50 is stuck.
[0040] In the condition of not impressing an electrical potential difference between a transparent electrode 41 and 42 with this modulated light component As shown in drawing 8 (A), while orientation of the 1st layer of the liquid crystal molecule in the drop in the modulated light layer 50 is carried out to X shaft orientations in 57 Since orientation of the 2nd layer is carried out to Y shaft orientations in 58, the 1st layer of the 2nd layer of a refractive-index difference is produced between 58 with 57, namely, a periodic change of a refractive index is produced in Z shaft orientations in the modulated light layer 50, and the reflected light is produced.
[0041] On the other hand, by impressing electric field to the modulated light layer 50 at Z shaft orientations, a transparent electrode 41 and where an electrical potential difference is impressed among 42, as shown in drawing 8 (B), the direction of orientation of the liquid crystal molecule in the drop in 1st layer 57 and the direction of orientation of the liquid crystal molecule in the drop in 2nd layer 58 change to Z shaft orientations, respectively. Therefore, the 1st layer of the 2nd layer of the refractive-index difference between 58 is lost with 57, and the reflected light disappears.
[0042] According to this modulated light component, in the state of reflection of drawing 8 (A), the 2nd layer of the 1st layer of the refractive-index difference between 58 becomes 57 and a very big thing, and sufficiently large reflectance spectrum half-value width is obtained.
[0043] The modulated light component of the 1st, 2nd, and 3rd example of a prior invention reflects the light of a specific wavelength field, or makes the light of a full wave length field penetrate according to the electrical potential difference impressed between an electrode 43 and 44 or between a transparent electrode 41 and 42, as mentioned above. By producing three modulated light components which follow, for example, make red, Green, and a blue wavelength field a reflected wave length field, respectively, and preparing a light absorption layer in the opposite side a superposition and outdoor daylight incidence side, the large color reproduction range can be obtained and a full color display is attained.
[0044] And as mentioned above, when change of the periodic refractive index in the modulated light layer 50 in a reflective condition becomes very large, sufficiently large reflectance spectrum half-value

width is obtained and it uses as a display device, lightness becomes high enough and a very good display property is acquired.

[0045] However, since the modulated light component of the 1st example of the prior invention shown in drawing 6 forms the electrodes 43 and 44 for impressing the electric field of the direction of a field of substrates 11 and 12 in a pixel, the numerical aperture of a pixel falls remarkably. Furthermore, considering the drive by the electric field of the direction of a field, it is the threshold voltage Vt between a transparency condition and a reflective condition. Vt=(piL/d) x(k2/epsilonodeltaepsilon) 1/2 - - (1)

It becomes. However, for L, an electrode 43, the distance between 44, and d are [the twist elastic modulus of liquid crystal and deltaepsilon of the thickness of the modulated light layer 50 and k2] the dielectric constant anisotropies of liquid crystal.

[0046] And since d is equivalent to the thickness for every layer which forms periodic structure, it is the value of wavelength of light and is very as small as about several 10-100nm. Therefore, while an electrical potential difference very high as threshold voltage Vt is needed and the drive of a component becomes difficult, power consumption increases.

[0047] Moreover, in order that the modulated light component of the 2nd and 3rd example of the prior invention shown in drawing 7 and drawing 8 may control the direction of orientation of a liquid crystal molecule by impressing a magnetic field in the manufacture process, a very strong magnetic field is needed. Therefore, it becomes difficult to impress a magnetic field uniformly over a large area, and there is difficulty the productivity of a component, and in respect of homogeneity.

[0048] Then, while visibility becomes good by the large color reproduction range being not only realizable, but being able to obtain the display of whenever [Takaaki] and especially the lightness of a white display improving sharply, it is made for a drive and manufacture of equipment to become easy in the reflective mold electrochromatic display which this invention can multicolor display.

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MEANS

[Means for Solving the Problem] While being able to take alternatively two conditions in the condition of absorbing with the condition of reflecting a specific wavelength field, respectively, in this invention In the reflective mold electrochromatic display with which the laminating of two or more modulated light components which differ in the above-mentioned specific wavelength field mutually was carried out two or more above-mentioned modulated light components It shall have dichroism to the above-mentioned specific wavelength field which established the above-mentioned specific wavelength field in the outdoor daylight incidence side of the dichroic mirror reflected alternatively and this dichroic mirror, respectively, and the other wavelength field should be equipped with the modulated light layer made to penetrate mostly.
[0050] In this case, two or more above-mentioned modulated light components can be used as three modulated light components which make each above-mentioned specific wavelength field red, Green, and a blue wavelength field.
[0051] In that case, as for the three modulated light components, it is desirable to carry out the laminating of what makes Green, red, and a blue wavelength field the above-mentioned specific wavelength field to order from an outdoor daylight incidence side.
[0052] Moreover, as for the dichroic mirror of the modulated light component of each above, it is desirable to adjoin the above-mentioned modulated light layer of the modulated light component, and to form by dielectric multilayers.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing an example of the reflective mold electrochromatic display of this invention.
[Drawing 2] It is drawing comparing and showing the color reproduction range by the reflective mold electrochromatic display of drawing 1 , and the color reproduction range by the reflective mold electrochromatic display of drawing 4 .
[Drawing 3] It is drawing comparing and showing the color reproduction range by the reflective mold electrochromatic display of drawing 1 , and the color reproduction range by the reflective mold electrochromatic display of drawing 4 .
[Drawing 4] It is drawing showing an example of the conventional reflective mold electrochromatic display.
[Drawing 5] It is drawing showing an example of the conventional modulated light component.
[Drawing 6] It is drawing showing the modulated light component of the 1st example of a prior invention.
[Drawing 7] It is drawing showing the modulated light component of the 2nd example of a prior invention.
[Drawing 8] It is drawing showing the modulated light component of the 3rd example of a prior invention.
[Description of Notations]
10G, 10R, 10B Modulated light component
11 12 Transparence substrate
21 22 Transparence pixel electrode
23M, 23C, 23Y Modulated light layer
25 Mechanical Component
26 Black Matrix
27G, 27R, 27B Dichroic mirror

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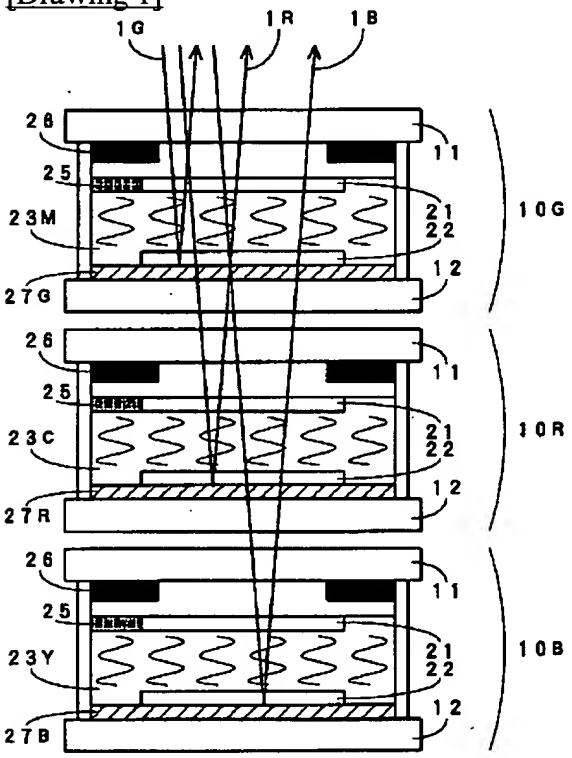
DRAWINGS

[Drawing 1]



[Drawing 2]

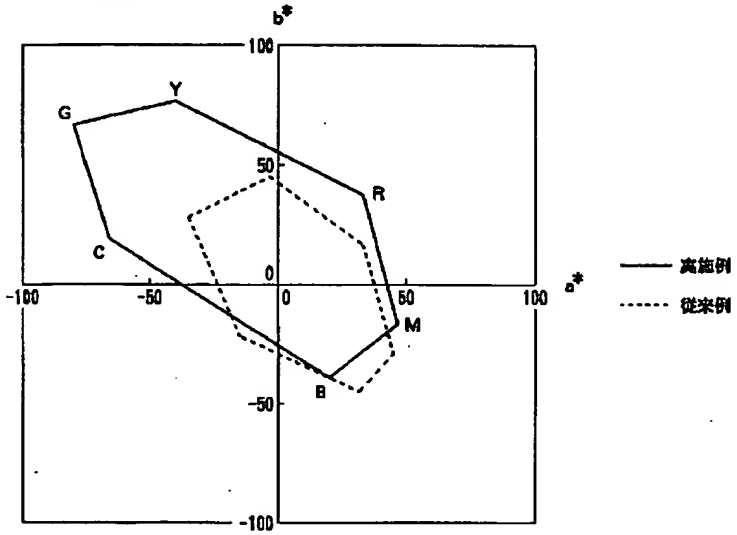
(A) 実施例の色再現範囲

	Y	G	C	B	M	R	W	K
L	77.59	72.20	72.82	28.77	39.97	38.87	78.14	27.04
a^*	-39.02	-79.76	-64.62	17.49	48.03	33.44	-28.97	-16.60
b^*	75.68	66.45	22.67	-39.65	-20.46	33.73	81.72	13.40

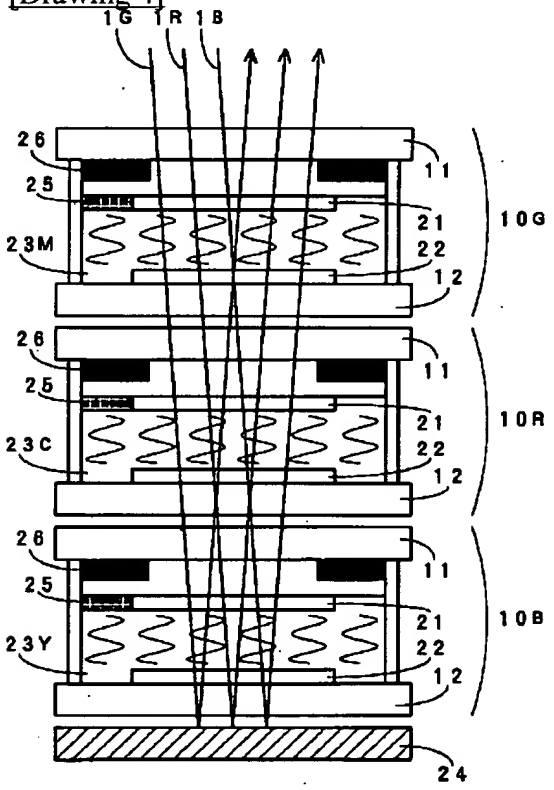
(B) 従来例の色再現範囲

	Y	G	C	B	M	R	W	K
L	46.84	35.22	39.22	17.73	28.35	26.21	49.79	13.87
a^*	-2.05	-34.69	-19.80	33.47	48.95	34.36	2.72	4.31
b^*	45.88	26.30	-19.18	-48.35	-30.15	19.03	-1.24	-2.11

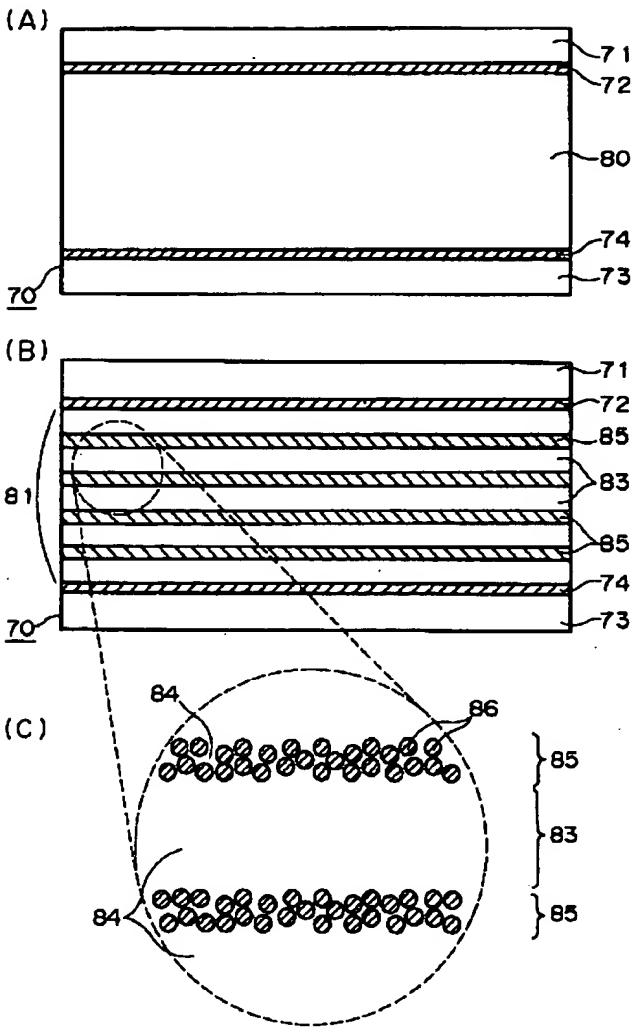
[Drawing 3]



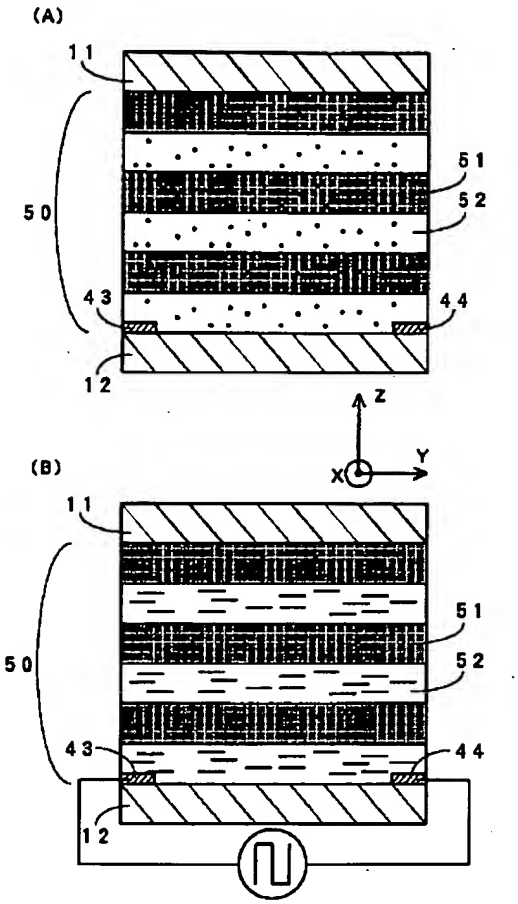
[Drawing 4]



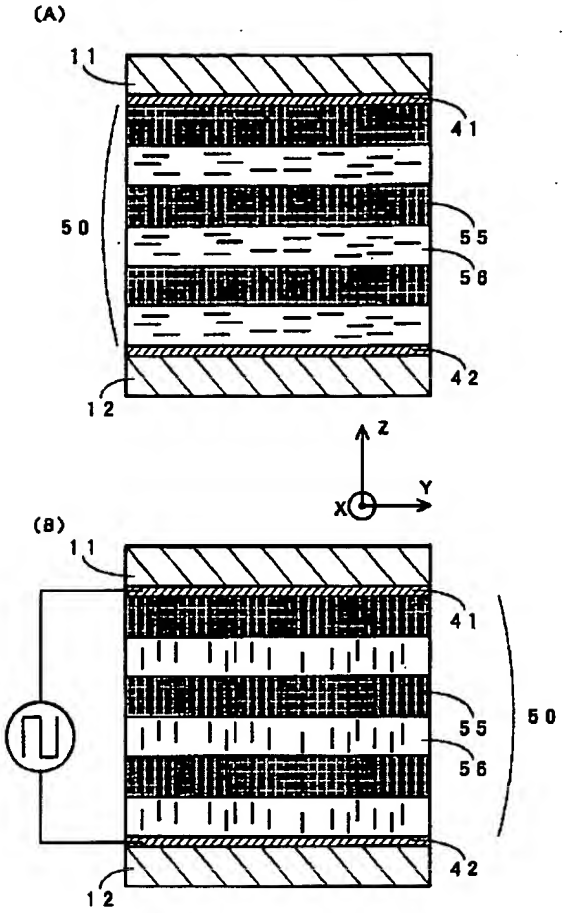
[Drawing 5]



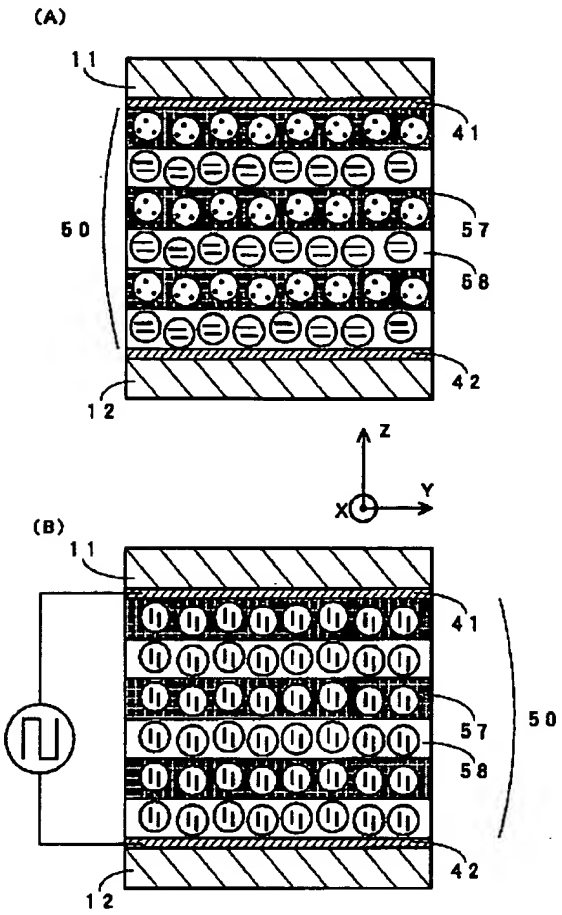
[Drawing 6]



[Drawing 7]



[Drawing 8]



[Translation done.]